Strengthening Climate Mitigation and Adaptation Strategies for Shrimp Pond-Dense Coastal Ecosystems

Through the Development of a Shrimp Pond GHG Calculator

LEAPS
Leveraging Climate-Smart Shrimp Aquaculture Solution

IDRC · CRDI
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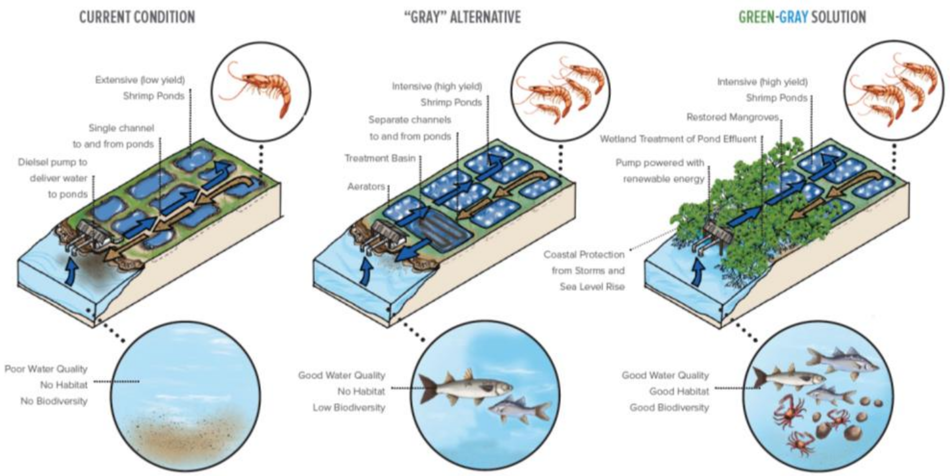
Climate-Smart Shrimp Aquaculture



Environmental Sustainability Improvement	Protection of Coastal Ecosystem	Strengthening Local Economy	Ensuring Social Equity

GHG Flux Simulation

- GHG inventory of shrimp ponds and mangrove ecosystem.
- Mangrove Health Index analysis.
- Sustainable aquaculture practice for smallholder farmers

Leveraging GEDSI Concept Institutionally and Substantively

- Livelihood mapping
- Women and youth role mapping
- Participative approaches in conducting research and data collection

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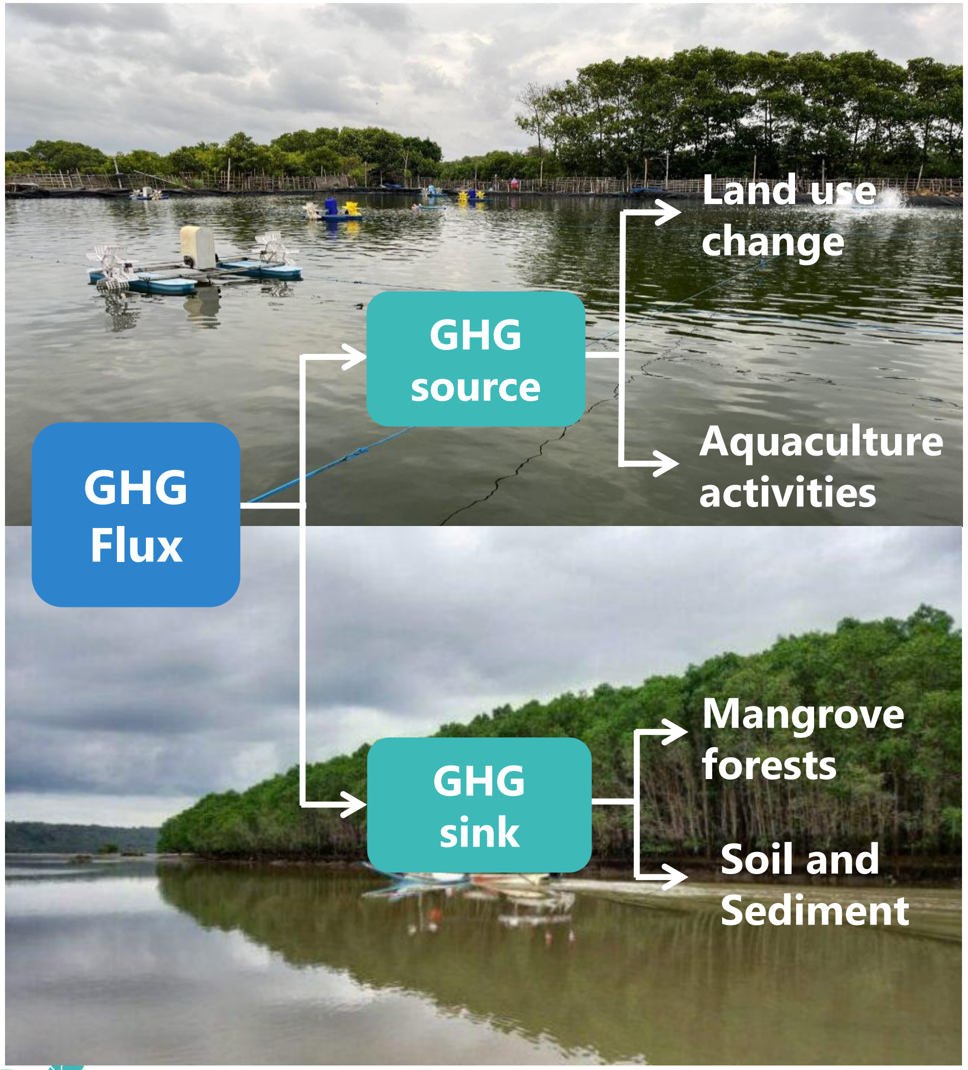
GHG Flux Simulation



Measuring Tools/Method	Progress to Date
Shrimp pond GHG inventory calculator	Shrimp Pond GHG Calculator V01 development has been completed. Initial analysis using interview data has been conducted
• Field survey • Carbon stock estimation using allometric formula and lab analysis	Baseline study covering above ground biomass and mangrove ecosystem health were conducted in 2024 by Konservasi Indonesia. Further assessment covering soil sampling has been conducted.

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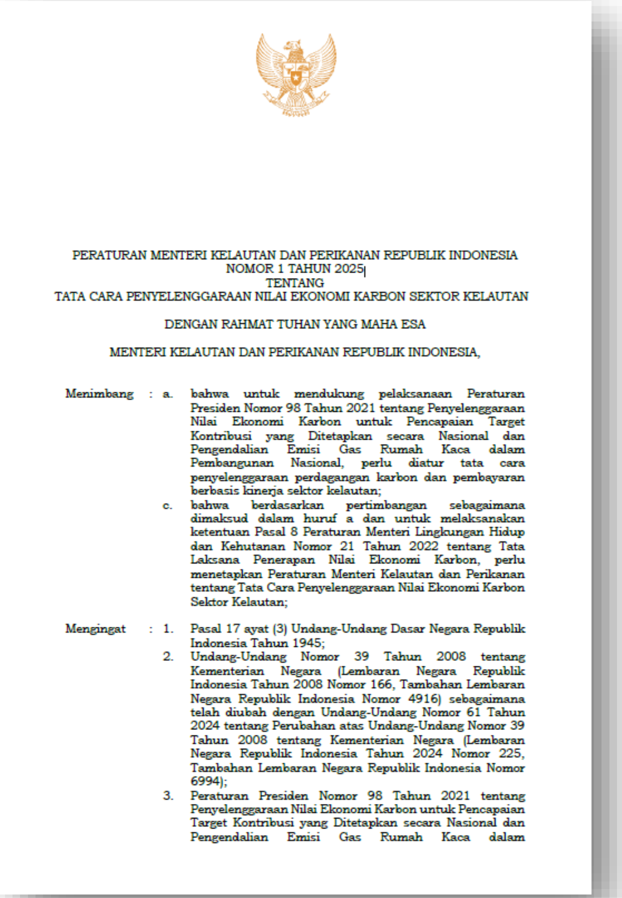
Greenhouse Gas Calculation as a Foundation for Climate Action Development

Greenhouse Gas Calculation → **Mapping the Highest Emission Sources** → **Preparation of Emission Reduction Strategies**

- GHG calculations identify **the contribution of an activity to climate change** and **map the source of emissions**. This will underlie the **preparation of emission reduction plans or climate actions**, such as the formulation of policies or emission reduction roadmaps.
- In addition to being used in the development of climate action, GHG calculations will also help the **monitoring process** of the **implementation of planned climate action**.


PERATURAN MENTERI KELAUTAN DAN PERIKANAN REPUBLIK INDONESIA
NOMOR 1 TAHUN 2025
TENTANG
TATA CARA PENYELENGGARAAN NILAI EKONOMI KARBON SEKTOR KELAUTAN

DENGAN RAHMAT TUHAN YANG MAHA ESA

MENTERI KELAUTAN DAN PERIKANAN REPUBLIK INDONESIA,

Menimbang : a. bahwa untuk mendukung pelaksanaan Peraturan Presiden Nomor 98 Tahun 2021 tentang Penyelenggaraan Nilai Ekonomi Karbon untuk Pencapaian Target Kontribusi yang Ditetapkan secara Nasional dan Pengendalian Emisi Gas Rumah Kaca dalam Pembangunan Nasional, perlu diatur tata cara penyelenggaraan perdagangan karbon dan pembayaran berbasis kinerja sektor kelautan;

c. bahwa berdasarkan pertimbangan sebagaimana dimaksud dalam huruf a dan untuk melaksanakan ketentuan Pasal 8 Peraturan Menteri Lingkungan Hidup dan Kehutanan Nomor 21 Tahun 2022 tentang Tata Laksana Penerapan Nilai Ekonomi Karbon, perlu menetapkan Peraturan Menteri Kelautan dan Perikanan tentang Tata Cara Penyelenggaraan Nilai Ekonomi Karbon Sektor Kelautan;

Mengingat : 1. Pasal 17 ayat (3) Undang-Undang Dasar Negara Republik Indonesia Tahun 1945;

2. Undang-Undang Nomor 39 Tahun 2008 tentang Kementerian Negara (Lembaran Negara Republik Indonesia Tahun 2008 Nomor 166, Tambahan Lembaran Negara Republik Indonesia Nomor 4916) sebagaimana telah diubah dengan Undang-Undang Nomor 61 Tahun 2024 tentang Perubahan atas Undang-Undang Nomor 39 Tahun 2008 tentang Kementerian Negara (Lembaran Negara Republik Indonesia Tahun 2024 Nomor 225, Tambahan Lembaran Negara Republik Indonesia Nomor 6994);

3. Peraturan Presiden Nomor 98 Tahun 2021 tentang Penyelenggaraan Nilai Ekonomi Karbon untuk Pencapaian Target Kontribusi yang Ditetapkan secara Nasional dan Pengendalian Emisi Gas Rumah Kaca dalam

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GHG Calculator Development Methodology

	Step	GHG / GEDSI approach	
completed	Activities mapping in various aquaculture schemes	Literature study on shrimp life cycle, types of aquaculture practice and activities on each practice	In-depth interview, participatory FGD with farmers, youth and women
completed	Development of GHG Calculator	Desk study to gather formula and emission factors utilizing IPCC, GHG Protocol, Ministry of Environment guideline, Ministry of Forestry research and Ministry of Energy and Mineral Resources	
completed	Calculator trial using interview data	In-depth interview with farmers	Data analysis utilizing excel-based GHG calculator
planned	Calculator enhancement	Desk study to gather formula and emission factors utilizing IPCC, GHG Protocol, Ministry of Environment guideline, Ministry of Forestry research and Ministry of Energy and Mineral Resources	
planned	Socialization & Data gathering	Questionnaire development, and socialization through participative FGD	
planned	GHG inventory for smallholder shrimp ponds	Data analysis utilizing excel-based GHG calculator, validation and review with relevant expert	Validation interview/ pFGD with farmers

GHG approach GEDSI approach

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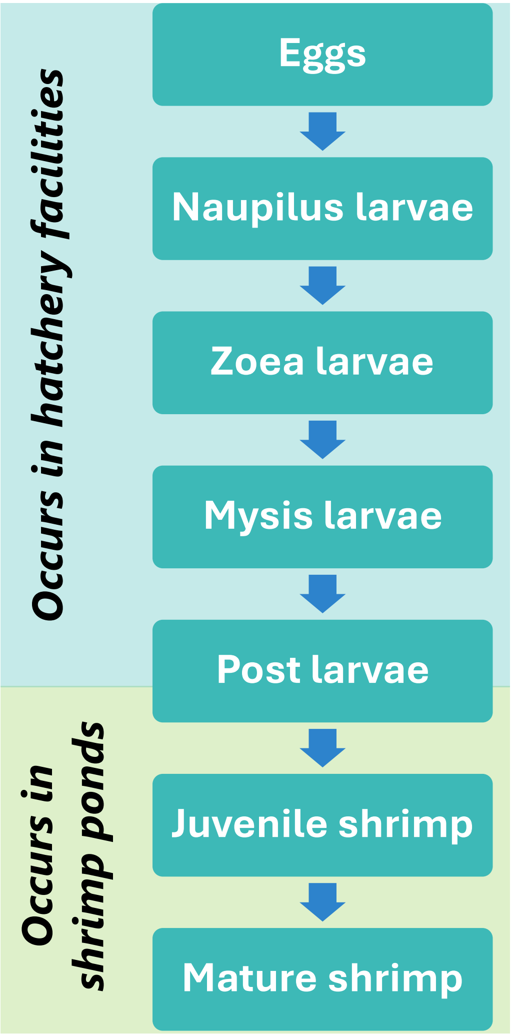
Shrimp Pond GHG Calculator V01 Development



GHG Calculator Component based on activities taking place in shrimp ponds

Scope	Activities	Tier	Reference Source
1	Stationary Combustion	*Tier 3*	*Ministry of Energy and Mineral Resources*
	Mobile Combustion	*Tier 3*	*Ministry of Energy and Mineral Resources*
	Refrigerant Emission	*Tier 3*	*Ministry of Energy and Mineral Resources*
	Water N2O	*Tier 1*	*IPCC*
	Water body CH4	*Tier 1*	*IPCC*
	Land Use Change Emission	*Tier 3*	*Ministry of Forestry*
2	Purchased Electricity	*Tier 3*	*Ministry of Energy and Mineral Resources*
	Purchased Fertilizer	*Tier 1*	*IPCC, WWF, FAO*
	Purchased Feeding Product	*Tier 1*	*IPCC, WWF, FAO*
	Purchased Shrimp Fries	*Tier 1*	*IPCC, WWF, FAO*
3	Wastewater CH4	*Tier 1*	*IPCC, WWF, FAO*
	Organic waste-shrimp biomass buried	*Tier 1*	*IPCC*
	Organic waste-shrimp biomass incinerated	*Tier 1*	*IPCC*

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Shrimp Pond GHG Calculator V01 Development

Aquaculture Model in Wringin Putih Village

	Criteria	Model Categorization based on GROBEST Manual, 2021	Model Categorization identified by farmers	
EXTENSIVE	Pond size	2-3Ha	2,000-2,500m2	TRADITIONAL
	Species produced	Black tiger (*P. monodon*) Mud crab (*Scylla serrata*) Other shrimp species and fish	White leg shrimp (*L. vannamei*) Mud crab (*Scylla serrata*) Other shrimp species and fish	
	Stocking density	1-3 ind m2	25-50 ind m2	
	Nutrient Input	Almost all nutrients from compounds feeds	Almost all nutrients from compounds feeds	
	Operational and Investment	Minimal investment, minimum to no technological intervention	Minimal investment No technological intervention	
SEMI-INTENSIVE	Pond size	2,000-10,000m2	1,000m2-5,000m2	TRADITIONAL +
	Culture area	0,5-2 Ha	1,000m2-5,000m2	
	Species produced	Black Tiger (*P. monodon*) White leg shrimp (*L. vannamei*)	White leg shrimp (*L. vannamei*) Mud crab (*Scylla serrata*) Other shrimp species and fish	
	Stocking density	4-10 ind m2 (black tiger) 20-50 ind m2 (white leg)	40-100 ind m2	
	Nutrient Input	All nutrients from compounds feeds	All nutrients from compounds feeds	
	Operational and Investment	Moderate investment and technological intervention	Moderate investment, at least utilize 2 aerators and 1 water pump	

Identified Activity Data in Shrimp Ponds from Traditional (T) and Traditional Plus (T+) Aquaculture Model in Wringin Putih Village

Data	Relevant Calculation	T	T+
Pool area (m2)	S1-land use change		
	S1-water body CH4		
	Data calibrator		
Shrimp production/Cycle	S1-water body N2O		
	FCR		
Number of aerator	S2-purchased electricity		
Number of water pumps	S2-purchased electricity		
Total feed (kg)/cycle	S2-purchased feed		
Dolomite lime (kg)/year	S2-purchased fertilizer		
Fertilizer Use/Year	S2-purchased fertilizer		
Shrimp fries density/m2	S2-purchased shrimp fries		
Number of cycles	Data calibrator		
Cycle length (months)	Data calibrator		

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Initial Analysis on Interview Data Utilizing Shrimp Pond GHG Calculator V01

PONDS	pond area (m2)	number of aerator	number of water pump	feed (kg))/cycle	dolomite lime (kg)	fertilizer	stock density	shrimp live weight (Kg)/cycle	Emission Intensity	Feed Conversion Rate
T*1	5000	2	1	800	500	EM4 2L	100	150	**7503**	**5,33**
T*2	1000	1	1	600	100	EM4 2L	40	80	**2814**	**7,5**
T*3	1000	1	1	600	100	EM4 2L	40	80	**2814**	**7,5**
T1	2500	-	-	350	250	-	50	100	**7503**	**3,5**
T2	2000	-	-	10	-	SP36 50kg	25	87	**3450**	**0,11**

Findings

- Samples are taken from ponds under the **extensive** or **traditional** model spectrum. There are **Traditional +** and **Traditional** pond. The main difference between those two is the usage of **aerator and water pump**.
- It is estimated that the fairly lowest emission intensity and closer to ideal FCR rate is found in T2 pond, the **low maintenance** one with **no technological intervention**. Key factor behind this findings are:
  - **Rapid cycle and soil treatment turnover**, resulting in highest shrimp tonnage in a year.
  - Low feeding product usage due to **rich healthy microbes** in water because of **soil treatment** and **fertilizer** usage.

Further analysis with more complex data will be conducted during the implementation phase of the project.

Potential Climate Adaptation Strategy for Smallholder Farmers

For smallholder farmers, enhancing their capacity in **disease identification and mitigation** is identified as the most accessible strategy to **boost productivity** while also **ensuring low-emission practice**.

$$emission\ intensity = \frac{emission\ estimation\ from\ aquaculture\ practice\ (CO_2e\ kg)}{commodity\ biomass\ (kg)}$$

Climate Actions	Accessibility
Rapid cycle and soil treatment turnover, resulting in highest shrimp tonnage in a year.	**Local knowledge adaptation strategy** that has been implemented through years. **Highly accessible.**
Low feeding product usage due to **rich healthy microbes** in water because of **soil treatment** and **fertilizer** usage.	**Local knowledge adaptation strategy** that has been implemented through years. **Highly accessible.**
Increasing production through **disease mitigation** and **data-based aquaculture strategy.**	Identified as one of **farmers' lack of capacity** that is going to be facilitated under **LEAPS project series of capacity building.**
Pond intensification through supporting technology and facilities.	Not accessible to most of the smallholder farmers but considered as an option. Strong financial and capacity building needed.
Commodity diversification to increase disease resilience and biomass which decrease emission intensity.	**Local knowledge adaptation strategy** that has been implemented through years. **Highly accessible.**

Further analysis with more complex data will be conducted during the implementation phase of the project.

Potential Climate Action from Local Knowledge and Communal Practice

Farmer Cooperation: Unlocking Access, Cutting Emissions

By **pooling resources through cooperative groups**, smallholder farmers **overcome access barriers** to feed and other supporting goods while **reducing operational emissions (mobile combustion)**, showing how collective action drives both equity and sustainability.

Women-led POKLAHSAR: Turning Rejected Shrimp into Value, Reducing Waste and Emissions, Boosting Local Economy

Smallholder ponds often produce **undersized shrimp that fail to meet market standards**, risking **higher emissions from wasted biomass**. Through POKLAHSAR, a women-led processing and marketing group, these products are transformed into value-added foods such as shrimp nuggets and fried meatballs. This initiative not only **reduces potential emissions** but also **strengthens household and village economy**, expanding women's leadership beyond household roles into formal decision-making in aquaculture value chains, by positioning women as innovators, not just support labor. .

Potential Climate Action from Local Knowledge and Communal Practice

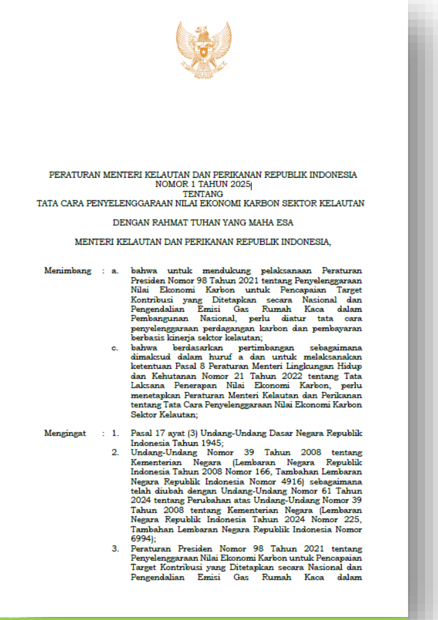
Traditional Ponds: Inclusive Family-based Aquaculture Reducing Operational and Emission Intensity

Traditional ponds serve as an **inclusive workspace** for farming families, where women and youth can directly participate in aquaculture. With stronger family involvement, farmers do not need to hire daily workers from outside the village, **avoiding additional costs** and **reducing operational emissions** from mobility and accommodation. This practice enables **intergenerational learning in pond management**, ensuring actor regeneration. Moreover, traditional ponds support **commodity diversification** such as crabs, fish, and shellfish, which contributes to lowering **emission intensity** by generating **higher overall biomass from diverse production.**

Summary and Recommendation

To support the implementation of fishery and aquaculture GHG inventory as the foundation of the carbon economic value in Indonesia, the development of this calculator has identified several gaps that need to be addressed, namely:

1. **Emission factor for feeding, fertilizer and shrimp fries**
   This would require local manufacturers, industries and hatcheries to conduct their own LCA resulting in more relevant emission factor for each product. Serving a more contextualized basis for Indonesia fishery GHG inventory.
2. **Emission factor for waterbody N2O, CH4**
   This would require more robust research on waterbody (especially shrimp ponds water) research in Indonesia.
3. **Development of aquaculture GHG calculator for other commodities in Indonesia**
   This would require wider studies and data sampling from other aquaculture commodities in Indonesia



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For the upcoming calculator development and enhancement, there are some things to further considerate and assess. These would enhance the calculator and hopefully result in a more objective GHG estimation:

1. Incorporating **the other commodities (mud crab, fish, clamshells) biomass** into the calculator
2. Incorporate **dead shrimp/ the other commodities biomass** into the calculator, to estimate GHG emission from organic waste.
3. Conduct **more robust data gathering and analysis**

Upcoming research topics following up this findings:

1. Assessing the effectiveness of local practice NbS strategy such as traditional **fertilizers and molasses** in term of aquaculture performance and emission reduction.
2. **Estimating mitigation strategy through mangrove restoration** utilizing GHG estimation and mangrove carbon stock analysis.

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